The heart of an astronaut, five years on

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In this image, JAXA astronaut Koichi Wakata, Expedition 38 Flight Engineer, demonstrates the ultrasound used to collect data for the Cardio Ox investigation, in the Columbus Module. Credit: NASA

The heart of an astronaut is a much-studied thing. Scientists have

analyzed its blood flow, rhythms, atrophy and, through journal studies, even matters of the heart. But for the first time, researchers are looking at how oxidative stress and inflammation caused by the conditions of space flight affect those hearts for up to five years after astronauts fly on the International Space Station. Lessons learned may help improve cardiovascular health on Earth as well.

Oxidative stress reflects an imbalance in the body's ability to handle toxic byproducts from normal, oxygen-consuming cell metabolism. This imbalance produces peroxides and free radicals, which contribute to a number of degenerative conditions. Evidence indicates that oxidative stress and resulting inflammation can accelerate the development of atherosclerosis, a disease in which plaque builds up inside arteries. This disease can lead to heart attacks and strokes.

For this investigation, called Cardio Ox, researchers at NASA's Johnson Space Center in Houston will look at the function and structure of arteries along with specific biomarkers in the blood and urine that indicate inflammation and oxidative stress. These biological samples will be taken from astronauts before their launch, 15 and 60 days after launch, 15 days before returning to Earth, and within days after landing.

The crew will also take ultrasound scans of the carotid artery thickness and brachial artery dilation, recognized indicators of cardiovascular health, at the same time points, for comparison with the biomarkers. The same measurements will be taken and ultrasounds performed at the regular check-ups that all astronauts have one, three and five years after flight.

In this image, NASA astronaut Reid Wiseman, currently a flight engineer aboard the International Space Station, during prelaunch ground training for use of the Ultrasound-2 device which is used for the Cardio Ox study. Credit: NASA

"This is the first cardiovascular study to cover such a long period," said Steven Platts, Ph.D., principal investigator. The data will create a picture over time, allowing researchers to examine whether blood vessel changes seen during flight returned to normal sometime after flight. They'll also be able to determine if the effects of oxidative stress grow worse over time or if astronauts experience chronic inflammation post-flight.

Many studies have looked at oxidative stress on Earth, but only astronauts are simultaneously exposed to so many factors known to cause it. The unique environment of a space mission combines a number of factors that can increase the risk of oxidative damage and inflammation, including radiation, psychological stress, reduced physical activity and,

in the case of extravehicular activity, increased oxygen exposure.

"It's a perfect storm of things known to cause oxidative stress all happening at the same time," Platts explained. "So this study will enable us to answer some important questions, such as, do these factors work together to make things worse? Are any of them at high enough exposure to cause damage?" Knowing more about how space may cause changes in cardiovascular health will help scientists develop measures to counter its negative effects, in space and on Earth.

The pre-flight data provide a snapshot of an astronaut's cardiovascular health before exposure to the space environment, which then makes it reasonable to assume that any changes are caused by exposure to the space environment and not by other factors. Other studies have looked at specific factors such as mental stress or exercise and their relationship to oxidative damage, but the space station provides a unique opportunity to integrate a variety of causes in a single person.

Typically, a study eliminates all variables except one and examines that one, but this investigation looks at how the entire workplace environment affects the body. The same factors also affect people in unique Earth-bound job environments, such as long-haul jet pilots or train engineers, those who work in a small room all day at a radiation plant, or in unique conditions such as Antarctica. Such situations subject people to stress similar to that experienced by astronauts. The disruption of daily rhythm and sleep patterns experienced in space could be extrapolated to shift workers on Earth as well.

Astronaut Scott Kelly participated in the investigation during his time in orbit and recently completed his one-year post-flight checkup. The study is continuing aboard the station, and a total of 12 astronauts in all will participate during the five-year investigation. You could say the subjects are really putting their hearts into it.

Provided by NASA